

GIS Software - A description in 1000 words ^{*}

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Software that is used to create, manage, analyze and visualize geographic data, i.e. data with a reference to a place on earth, is usually denoted by the umbrella term 'GIS software'. Typical applications for GIS software include the evaluation of places for the location of new stores, the management of power and gas lines, the creation of maps, the analysis of past crimes for crime prevention, route calculations for transport tasks, the management of forests, parks and infrastructure, such as roads and water ways, as well as applications in risk analysis of natural hazards, and emergency planning and response. For this multitude of applications different types of GIS functions are required and different categories of GIS software exist, which provide a particular set of functions needed to fulfill certain data management tasks. We will first explain important GIS software concepts, then list the typical tasks accomplished with GIS software, describe different GIS software categories, and finally provide information on software producers and projects.

GIS Software Concepts

To represent a geographic object in a GIS, e.g. a building or a tree or a forest, a data representation has to be established first. GIS usually provide two different possibilities to represent a geographic phenomenon: the raster representation and the vector representation. In the raster representation a regular mesh of cells is used, where every cell records the value of the attribute that describe the phenomenon - like the Red/Green/Blue values in a digital image. Rasters are typically used to represent variables that are continuous over space, such as terrain elevations or land cover. In the vector model, which is commonly used to store objects that are spatially discrete, every object is represented by a (vector) geometry (e.g.; a point, a line, or a polygon) and value fields that describe the non-spatial object properties, the so-called 'attributes', in a table. For instance, a building might be represented by a rectangle geometry and have attached two fields that describe the construction year and the owner.

In GIS software geographic objects that have the same geometric and attribute representation are typically grouped in so-called 'layers' to simplify data management tasks. For instance, all buildings that are represented by polygons and have information on owner and construction year are grouped in a layer 'buildings'. In Figure 1 we show the typical graphical user interface of a GIS software package that includes the concept of geometries (map view) connected to values in tables (attribute view), as well as layers that contain one class of objects (e.g. rivers).

^{*} accepted as entry "GIS software" for the *Encyclopaedia of Geography*, B. Warf (ed), Sage Pub.

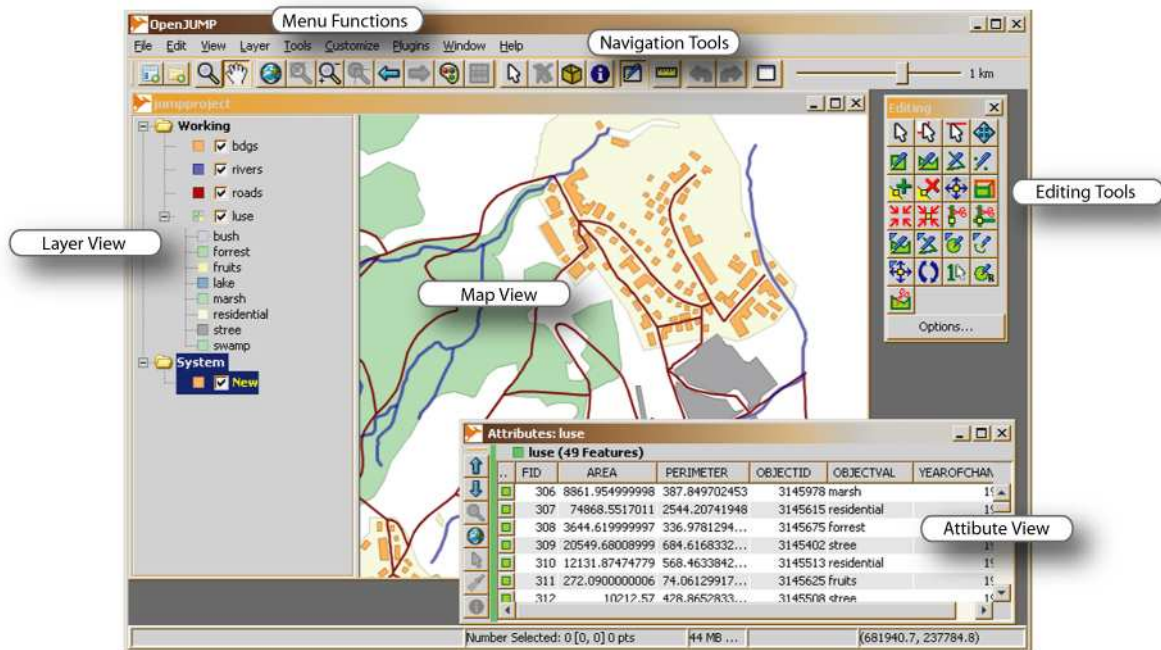


Figure 1: A typical desktop GIS user interface with map view, layer view, attribute view, tools for navigating and exploring data, as well as tools for creating and modifying geometries.

Typical Tasks Accomplished with GIS Software

Before any geographic analysis can take place the data need to be derived from field work, maps or satellite imagery, or acquired from data providers. Hence, data need to be created (1) and - in case something has changed - edited (2), and then stored (3). If data are obtained from other sources they need to be viewed (4) and eventually integrated (conflation) with existing data (5). To answer particular questions, e.g. who is living in street X and is affected by the planned renewal of a power line, the data are queried (6) and analyzed (7). However, some specific analysis tasks may require a data transformation and manipulation (8) before any analysis can take place. The query and analysis results can finally be displayed on a map (9).

GIS Software Categories

Different types of GIS software exist with different functionality, as not every GIS user needs to carry out all of the above tasks. For instance an assistant in the public services department of a city may only provide information on house owners to construction companies and does not need to edit the cadastral dataset.

Table 1 and Figure 2 summarize commonly used GIS software categories. Desktop GIS usually serve all GIS tasks and are sometimes classified into three functionality categories: GIS Viewer, GIS Editor, and GIS Analyst. Spatial Database Management Systems (DBMS) are mainly used to store the data, but often also provide (limited) analysis and data manipulation functionality. WebMap Servers

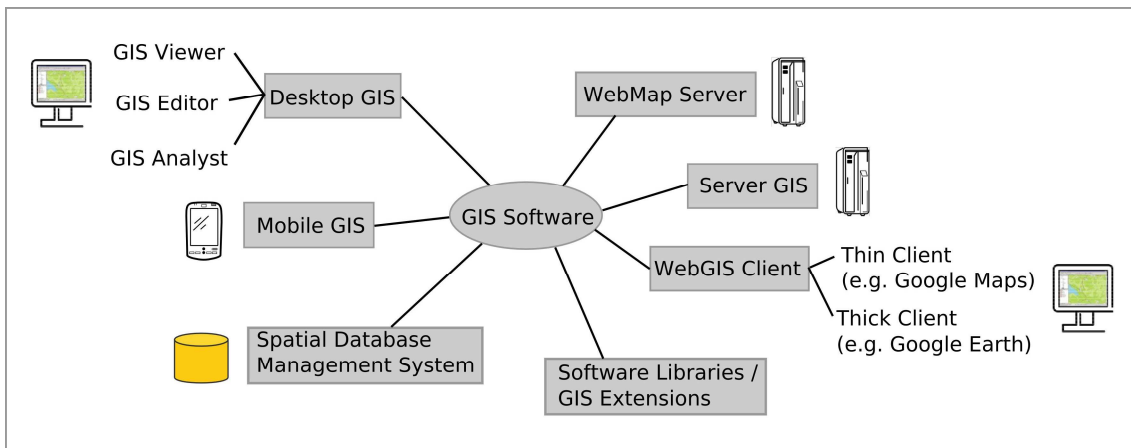


Figure 2: Different types of GIS software.

are used to distribute maps and data over the internet¹. Similarly, WebGIS Clients are used for data display and to access analysis and query functionality from Server GIS over the internet or intranet. Libraries and Extensions provide additional (analysis) functionality that is not part of the basic GIS software, for instance functions for network and terrain analysis, or functions to read specific data formats. Finally, Mobile GIS are often used for field data collection.

Table 1: Typical tasks accomplished with different GIS software. ● standard functionality, ◇ optional functionality.

GIS tasks vs. GIS software category	viewing	creation	editing	storage	conflation	transformation	query	analysis	create maps
Desktop GIS									
Viewer	●			●			●		◇
Editor	●	●	●	●		◇	●		●
Analyst	●	●	●	●	●	●	●	●	●
Spatial DBMS									
WebMap Server	●	◇	◇				●		●
Server GIS									
				●	●	●	●	●	●
WebGIS Client									
Thin Client	●						●		
Thick Client	●	●	●	●			●	●	●
Mobile GIS									
	●	●	●	●			●		
Libraries / Extensions									
				●	●	●		●	●

¹ Two important standards of the Open Geospatial Consortium (OGC) for map and geodata distribution via WebMap Servers are the Web Map Service (WMS) and Web Feature Service (WFS).

Software Manufacturers and Projects

GIS software is not only provided by companies but increasingly also by free and open source software projects. While commercial vendors usually offer products for all of software categories, open software projects often concentrate on a single category, e.g. desktop GIS or WebMap server. The key players in the GIS software market today are Autodesk, Bentley, ESRI Inc., GE (Smallworld), Pitney Bowes (MapInfo), and Intergraph. GIS software companies tend to target specific application domains. For instance, ESRI's ArcGIS product tends to be mainly used for business analysis, planning, and environmental applications, while Autodesk, GE and Bentley products are rather used in utility and facility management. Competitive GIS software that is developed by free software projects exists as well - especially with respect to server applications (MapServer, GeoServer) and spatial DBMS (PostGIS). Free desktop GIS projects, such as Quantum GIS and gvSIG, currently experience growing user communities. Such free GIS software rather complements the set of proprietary software instead of competing with it.

Further Readings

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